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## PHOTOSPHERIC ORIGINS OF CHROMOSPHERIC AND CORONAL ACTIVITY

Contract NAS8-39746  
 Progress Report for 1 February 1995 to 1 May 1995

### Introduction and Summary

This contract is for a research study of the origins of activity in the upper atmosphere of the Sun. The approach is to collect high resolution images of the lower atmosphere on observing runs at the Swedish Solar Observatory on La Palma, Canary Islands, Spain. The best observations are analyzed and compared with data from other telescopes and/or theoretical models, to study magnetic flux emergence, coronal heating, and various dynamic phenomena and transients. Software for analysis and visualization of the data is developed as needed. Scientific results are reported at conferences and published in the appropriate journals. The contract is being performed by the Solar and Astrophysics Laboratory, part of the Lockheed Palo Alto Research Laboratory (LPARL) of the Research and Development Division (RDD) of Lockheed Missiles and Space Co., Inc. (LMSC). The principal investigator is Dr. Theodore Tarbell, and the research is done by him and other scientific staff at LPARL, Dr. Richard Shine in particular, often in collaboration with visiting scientists and students from other institutions.

There was a modest level of activity in this period, primarily in the area of sharpening our software tools and using them to slice various La Palma datacubes. A new funding increment was received, along with an extension of the period of performance through 1 February, 1996.

### Major Activities During This Reporting Period

Work continued on interface tools for solar data analysis software, although more time was spent during this quarter using these tools than on development. A tool was added to conveniently make and play movie cubes from a series of files. It allows interactively selecting a subarea from the series and adjusting the size and intervals until the movie fits into local memory. Most of our data sets are much too large to be played as a movies cube in their entirety. It has proved very useful for looking at our South Pole data sets and for evaluating the results of image processing on our La Palma movies. Playing the locally stored movie also uses a widget interface that allows speed and range adjustments with the usual "VCR" buttons plus a "rock" button which plays the movie in a forward/backward sequence.

We finally provided a FITS format read capability in our image browser tool. The file type is automatically determined, the user doesn't need to know. Additional file format types can now be easily added as we encounter a need for them.

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 Feb. - 1 May 1995 (Lockheed  
 Missiles and Space Co.) 3 p

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Preliminary work has also begun on re-organizing our movies sets to allow easier and more intuitive access to them from a graphical interface. Currently we just have a list of "known" movies and flowmaps that our tools access. Movies not on these lists have to be typed in by hand. A new scheme, not worked out in detail yet, will provide a common, self-identifying interface to all our movie and single image data. This will also stimulate the development of tools to manage and list the data. We have a major problem just tracking where data sets are and who is currently using them. We are always running out of disk space for example, and need to eliminate old data to get new processing jobs done.

### **Other Activities**

Louis Strous, who completed his Ph.D. degree based on La Palma data analysis, moved to Sacramento Peak in January as a post-doc working for Dr. Phil Goode. The first paper based on his thesis results, entitled "Phenomena in an emerging active region. I. Horizontal dynamics," by Strous, Scharmer, Tarbell, Title and Zwaan, was submitted for publication in *Astronomy and Astrophysics*.

Dr. Shine is continuing analysis of our 6/14/94 data in several areas but currently concentrating on documenting some emerging flux events seen in the area around the sunspot. These were the topic of a poster given at the December AGU where some preliminary results were shown. Another poster paper, showing our more recent results, is scheduled for the June Solar Physics meeting in Memphis. Some data taken on other days of the same active region also looks promising for this study.

Another paper to be presented at the Memphis meeting is a description of our observing configuration for last summer's run entitled "Frame Selection Techniques for Solar Movies" by Shine, Tarbell, Title, Scharmer, Simon, Brandt, and Berger. The abstract is attached.

We continued to assist Toshi Shimizu, graduate student at Tokyo University, who is analyzing some 1992 La Palma data for his thesis on active region transient X-ray brightenings. He has submitted an abstract on this work for the IAU Colloquium "Magnetodynamic Phenomena in the Solar Atmosphere" in Tokyo in May.

Keith Strong continued working on editing the SMM monograph entitled "The Many Faces of the SUN," but it is still not quite finished.

### **Spending Status**

At the end of this quarter, approximately 57% of the contract cost value has been spent and approximately 57% of the work has been completed. We received an additional \$104 K of funding in this quarter.

### **Plans for the Period 1 May Through 1 August 1995**

1. Continue the collaborative data analysis projects and publications described above.

2. Continue developing and sharing our data analysis software.
3. Present the papers at the IAU Colloquium and the June SPD Meeting.
4. Analyze the polarimetric calibration data from the summer 1994 observing run and possibly from the 1992 run also for comparison.
5. Complete editing of the SMM monograph and send it to the printer.

#### Frame Selection Techniques for Solar Movies

R. A. Shine, T. Tarbell, A. Title (LPARL), G. Scharmer (SSO), G. Simon (AFSC/PL/GPSS), P. Brandt (KIS), T. Berger (SU)

Real time frame selection techniques combined with new detector systems have considerably improved the quality of solar movies taken at the Swedish Solar Vacuum Telescope (SSVT) on La Palma during the 1993 and 1994 observing seasons. We describe the hardware and software used for recording multi-spectral data with 3 cameras simultaneously in June 1994. Two of the detectors used fixed filters, one at the G band (430.4 nm, about 0.8 nm bandpass) and the other centered on the Ca II K line at 393.4 nm (0.3 nm bandpass). At a spatial scale of 16 pixels per arc second, these were able to use exposures near 30 ms, which is about the temporal scale of atmospheric distortions. Using a Kodak Megaplug 1.4 CCD system connected to a DEC Alpha computer, about 5 frames per second could be exposed, loaded into memory, and evaluated. The best frame over a 20 second interval was then recorded. The third camera used the Lockheed narrow band tunable filter which cycled between several wavelength and polarization settings to obtain images that can be combined to make magnetograms and dopplergrams as well as continuum and H-alpha images. This used a Kodak Megaplug 1.6 CCD with a scale of 10 pixels per arc second. Exposures depended on the filter setting and typically ranged from 16ms to 300 ms. Even for the longer exposures, frame selection makes a significant difference. Some possibilities for further quality improvements, especially for the longer exposure images, are discussed.

Data from these 3 camera systems has been processed and co-aligned for a few of the better days. The resulting movies and some early results will be shown.

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